

Claims

What is claimed is:

1. A method comprising:
 - 5 a) providing a symbol vector table comprising symbol vectors corresponding to potential combinations of transmitted symbols;
 - b) determining first Euclidean distances between a received signal and a plurality of the symbol vectors in light of corresponding channel responses;
 - 10 c) selecting a first smallest distance from the first Euclidean distances as a hard decision;
 - d) determining a bit vector corresponding to the first smallest distance; and
 - e) for each bit in the bit vector:
 - 15 i) selecting second Euclidean distances corresponding to a competing bit from the first Euclidean distances; and
 - ii) selecting a competing smallest distance from the second Euclidean distances as a soft demapping value.
- 20 2. The method of claim 1 wherein for each bit in the bit vector, further comprising determining a difference between the hard decision and the corresponding soft demapping value.
3. The method of claim 2 wherein the difference is a log likelihood ratio.
- 25 4. The method of claim 2 further comprising decoding the differences for each bit using channel decoding to recover transmitted bits.
5. The method of claim 1 wherein the first Euclidean distances are calculated using:
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$$\left\{ \sum_{i=1}^N \left| r_i - \sum_{j=1}^M h_{ij} s_j \right|^2 \right\},$$

such that r is the received signal, s_i is a symbol vector, h_{ij} is a channel response vector, N is a number of receiver antennas, and M is a number of transmitter antennas.

- 5 6. The method of claim 5 wherein the channel decoding is Turbo decoding.
7. The method of claim 1 wherein the bit vector is determined by identifying one of the symbol vectors corresponding to the hard
10 decision and selecting the bit vector based on the one of the symbol vectors.
8. The method of claim 1 further comprising creating a Euclidean distance table comprising the first Euclidean distances and creating a plurality of
15 reduced Euclidean distance tables comprising the second Euclidean distances, wherein the first smallest distance is selected from the Euclidean distance table and the competing smallest distances for each bit are selected from corresponding ones of the reduced Euclidean distance tables.
- 20 9. The method of claim 1 further comprising:
 - a) decoding the received signal, which originates from a plurality of transmit antennas, using a separate STC decoding technique to determine a plurality of initial solutions;
 - 25 b) identifying a limited area about each of the initial solutions; and
 - c) creating a decoding space corresponding to the limited area, wherein the first Euclidean distances are determined from within the limited area.
- 30 10. The method of claim 9 wherein the limited area corresponds to a limited set of constellation points in a constellation lattice containing constellation points corresponding to possible symbols transmitted from the plurality of transmit antennas.

11. The method of claim 9 wherein the limited area corresponds to a set of four constellation points in a constellation lattice containing constellation points corresponding to possible symbols transmitted from the plurality of transmit antennas.
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12. The method of claim 9 wherein the decoding space is a limited space in a multi-dimensional constellation lattice corresponding to a limited set of constellation points.
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13. The method of claim 9 wherein there is an initial solution for each of the plurality of transmit antennas.
14. The method of claim 9 wherein the separate STC decoding technique is zero-forcing.
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15. The method of claim 9 wherein the separate STC decoding technique is minimum mean square error decoding.
16. A system for receiving signals comprising decoder circuitry adapted to:
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- a) provide a symbol vector table comprising symbol vectors corresponding to potential combinations of transmitted symbols;
 - b) determine first Euclidean distances between a received signal and a plurality of the symbol vectors in light of corresponding channel responses;
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 - c) select a first smallest distance from the first Euclidean distances as a hard decision;
 - d) determine a bit vector corresponding to the first smallest distance; and
 - e) for each bit in the bit vector:
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 - i) select second Euclidean distances corresponding to a competing bit from the first Euclidean distances; and
 - ii) select a competing smallest distance from the second Euclidean distances as a soft demapping value.

17. The system of claim 16 wherein for each bit in the bit vector, the decoding circuitry is further adapted to determine a difference between the hard decision and the corresponding soft demapping value.

5 18. The system of claim 17 wherein the difference is a log likelihood ratio.

19. The system of claim 17 wherein the decoding circuitry is further adapted to decode the differences for each bit using channel decoding to recover transmitted bits.

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20. The system of claim 16 wherein the first Euclidean distances are calculated using:

$$\left\{ \sum_{i=1}^N \left| r_i - \sum_{j=1}^M h_{ij} s_j \right|^2 \right\},$$

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such that r is the received signal, s_i is a symbol vector, h_{ij} is a channel response vector, N is a number of receiver antennas, and M is a number of transmitter antennas.

21. The system of claim 20 wherein the channel decoding is Turbo decoding.

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22. The system of claim 16 wherein to determine the bit vector, the decoding circuitry is further adapted to identify one of the symbol vectors corresponding to the hard decision and select the bit vector based on the one of the symbol vectors.

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23. The system of claim 16 wherein the decoding circuitry is further adapted to create a Euclidean distance table comprising the first Euclidean distances and create a plurality of reduced Euclidean distance tables comprising the second Euclidean distances, wherein the first smallest distance is selected from the Euclidean distance table and the competing smallest distances for each bit are selected from corresponding ones of the reduced Euclidean distance tables.

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24. The system of claim 16 wherein the decoding circuitry is further adapted to:
- a) decode the received signal, which originates from a plurality of transmit antennas, using a separate STC decoding technique to determine a plurality of initial solutions;
 - b) identify a limited area about each of the initial solutions; and
 - c) create a decoding space corresponding to the limited area, wherein the first Euclidean distances are determined from within the limited area.
25. The system of claim 24 wherein the limited area corresponds to a limited set of constellation points in a constellation lattice containing constellation points corresponding to possible symbols transmitted from the plurality of transmit antennas.
26. The system of claim 24 wherein the limited area corresponds to a set of four constellation points in a constellation lattice containing constellation points corresponding to possible symbols transmitted from the plurality of transmit antennas.
27. The system of claim 24 wherein the decoding space is a limited space in a multi-dimensional constellation lattice corresponding to a limited set of constellation points.
28. The system of claim 24 wherein there is an initial solution for each of the plurality of transmit antennas.
29. The system of claim 24 wherein the separate STC decoding technique is zero-forcing.
30. The system of claim 24 wherein the separate STC decoding technique is minimum mean square error decoding.

31. A method comprising:
- a) determining first terms associated with differences between a received signal and a plurality of symbol vectors in light of corresponding channel responses, the symbol vectors corresponding to potential combinations of transmitted symbols;
 - b) selecting a first smallest term from the first terms as a hard decision;
 - c) determining bits corresponding to the first smallest term; and
 - d) for each bit of the bits:
 - i. selecting second terms corresponding to a competing bit from the first terms; and
 - ii. selecting a competing smallest term from the second terms as a soft demapping value.
32. The method of claim 31 wherein for each bit, further comprising determining a difference between the hard decision and the corresponding soft demapping value.
33. The method of claim 32 wherein the difference is a log likelihood ratio.
34. The method of claim 32 further comprising decoding the differences for each bit using channel decoding to recover transmitted bits.
35. The method of claim 31 wherein the first and second terms are Euclidean distances.
36. The method of claim 31 wherein the first terms are calculated using:

$$\left\{ \sum_{i=1}^N \left| r_i - \sum_{j=1}^M h_{ij} s_j \right|^2 \right\}.$$